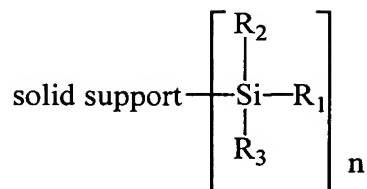
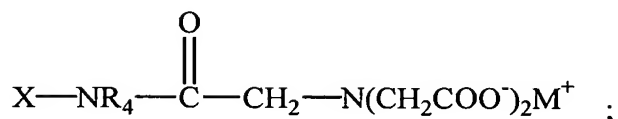


# CLAIMS

1. A composition comprising:



wherein R<sub>1</sub> is



X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R<sub>2</sub> and R<sub>3</sub> are independently selected from R<sub>1</sub>, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-Y<sub>1</sub>Y<sub>2</sub>Y<sub>3</sub>, wherein Y<sub>1</sub>, Y<sub>2</sub> and Y<sub>3</sub> are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

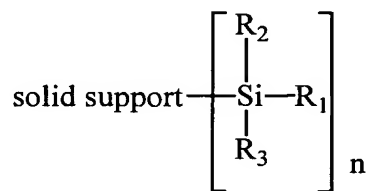
R<sub>4</sub> is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M is a metal ion; and

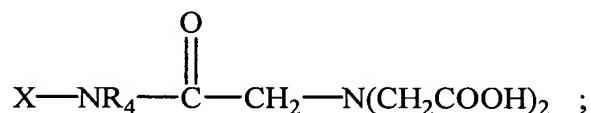
n is an integer ≥1.

2. The composition of claim 1, wherein the metal ion has an oxidation state of +1 to +6.
3. The composition of claim 2, wherein the metal ion is nickel, copper, cobalt, iron, zinc or gallium.
4. The composition of claim 1, wherein X is a saturated alkylene group or a substituted saturated alkylene group.
5. The composition of claim 1, wherein X is a saturated alkylene group of up to 10 carbon atoms or a substituted saturated alkylene group of up to 10 carbon atoms.

6. The composition of claim 5, wherein X is  $-(CH_2)_3-$ .
7. The composition of claim 1, wherein the solid support is selected from the group consisting of silica gels, siliceous oxides, solid silicas, magnetic silica particles, crystalline silicas, vitreous silicas, aluminum oxide, and combinations thereof.
8. A composition comprising:



wherein  $R_1$  is



X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

wherein  $R_2$  and  $R_3$  are independently selected from  $R_1$ , a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si- $Y_1Y_2Y_3$ , wherein  $Y_1$ ,  $Y_2$  and  $Y_3$  are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

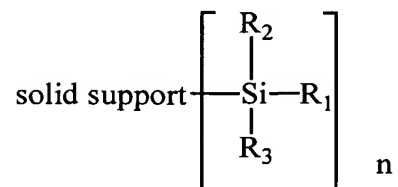
$R_4$  is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom; and

n comprises an integer  $\geq 1$ .

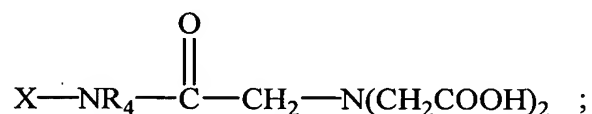
9. The composition of claim 8, wherein X is a saturated alkylene group or a substituted saturated alkylene group.
10. The composition of claim 8, wherein X is a saturated alkylene group of up to 10 carbon atoms or a substituted saturated alkylene group of up to 10 carbon atoms.
11. The composition of claim 10, wherein X is  $-(CH_2)_3-$ .

12. The composition of claim 8, wherein the solid support is selected from the group consisting of silica gels, siliceous oxides, solid silicas, magnetic silica particles, crystalline silicas, vitreous silicas, aluminum oxide, and combinations thereof.

13. A method of making a modified solid support comprising:



wherein R<sub>1</sub> is



X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R<sub>2</sub> and R<sub>3</sub> are independently selected from R<sub>1</sub>, a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or O-Si-Y<sub>1</sub>Y<sub>2</sub>Y<sub>3</sub>, wherein Y<sub>1</sub>, Y<sub>2</sub> and Y<sub>3</sub> are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety;

R<sub>4</sub> is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom; and

n comprises an integer ≥1,

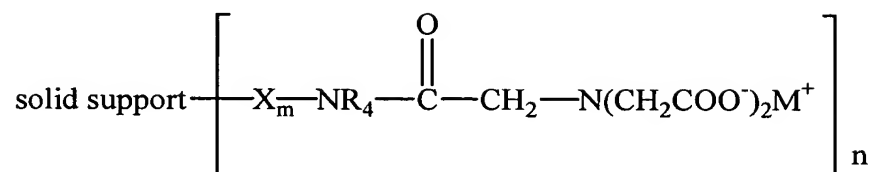
comprising:

- (a) contacting a solid support with an aminosilane compound to form a first complex, having a silanol bond between the solid support and the aminosilane compound; and
- (b) contacting the first complex with nitrilotriacetic acid to form a modified solid support having an amide bond between the nitrilotriacetic acid and the first complex.

14. The method of claim 13, further comprising contacting the modified solid support with a metal ion solution to form a metal-modified solid support.

15. The method of claim 13, wherein the aminosilane compound contains a saturated alkylene chain or a substituted saturated alkylene chain.
16. The method of claim 13, wherein the aminosilane compound is aminopropylsilane.
17. The method of claim 13, wherein the aminosilane compound is selected from the group consisting of aminopropylsilane, propylethylenediaminosilane, and aminopropyltrimethoxysilane compounds.
18. The method of claim 14, wherein the solid support is selected from the group consisting of silica gels, siliceous oxides, solid silicas, magnetic silica particles, crystalline silicas, vitreous silicas, aluminum oxide, and combinations thereof.
19. The method of claim 14, wherein the metal ion has an oxidation state of +1 to +6.
20. The method of claim 19, wherein the metal ion is nickel, copper, cobalt, iron, zinc or gallium.

21. A composition comprising:



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R<sub>4</sub> is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

M<sup>+</sup> is a metal ion;

n is an integer ≥1; and

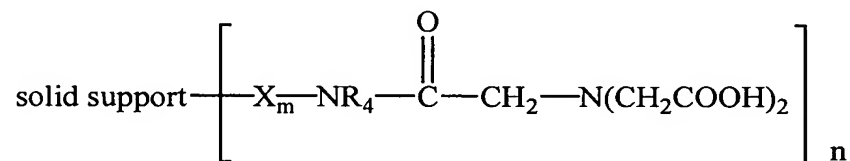
m is 0 or 1.

22. The composition of claim 21, wherein the metal ion has an oxidation state of +1 to +6.

23. The composition of claim 22, wherein the metal ion is nickel, copper, cobalt, iron, zinc, or gallium.

24. The composition of claim 21, wherein the solid support is selected from the group consisting of agarose, polyacrylamide, cellulose, plastic, polysaccharide, nylon, nitrocellulose, polystyrene, latex methacrylate, and combinations thereof.

25. A composition comprising:



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

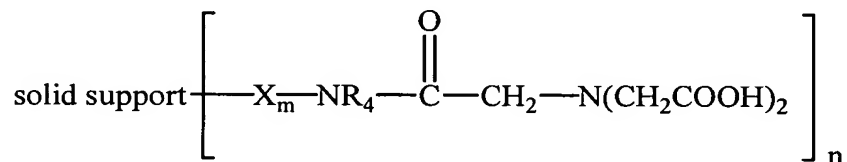
R<sub>4</sub> is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

n is an integer ≥1; and

m is 0 or 1.

26. The composition of claim 25, wherein the solid support is selected from the group consisting of agarose, polyacrylamide, cellulose, plastic, polysaccharide, nylon, nitrocellulose, polystyrene, latex, methacrylate, and combinations thereof.

27. A method of making a modified solid support comprising:



wherein X is a substituted or unsubstituted alkylene moiety, a substituted or unsubstituted aralkylene moiety, or a substituted or unsubstituted arylene moiety;

R<sub>4</sub> is a hydrocarbon moiety, a substituted hydrocarbon moiety, or a hydrogen atom;

n is an integer ≥1; and

m is 0 or 1;

comprising,

(a) contacting a solid support comprising a free -NR<sub>4</sub>H group with nitrilotriacetic acid to form an amide bond between the nitrilotriacetic acid and the -NR<sub>4</sub>H group.

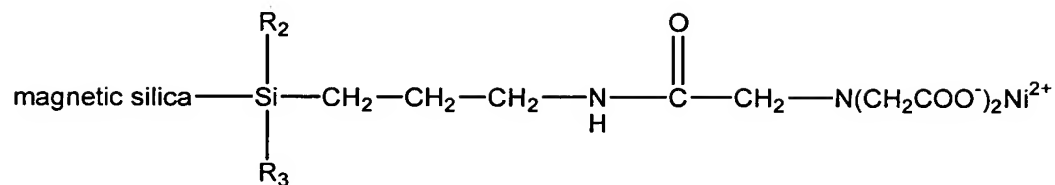
28. The method of claim 27, further comprising contacting the modified solid support with a metal ion solution to form a metal-modified solid support.

29. The method of claim 27, wherein the solid support is selected from the group consisting of agarose, polyacrylamide, cellulose, plastic, polysaccharide, nylon, nitrocellulose, polystyrene, latex methacrylate, and combinations thereof.

30. The method of claim 27, wherein the metal ion has an oxidation state of + 1 to + 6.

31. The method of claim 30, wherein the metal ion is nickel, copper, cobalt, iron, zinc, or gallium.

32. A composition comprising



wherein  $\text{R}_2$  and  $\text{R}_3$  are independently selected from  $\text{R}_1$ , a hydrocarbon moiety, a substituted hydrocarbon moiety, a halogen atom, a hydrogen atom, a hydroxy, a thiol, an amine, a silanol bond to the solid support, a bond to another silane ligand, or  $\text{O-Si-Y}_1\text{Y}_2\text{Y}_3$ , wherein  $\text{Y}_1$ ,  $\text{Y}_2$  and  $\text{Y}_3$  are independently selected from a hydrocarbon moiety or a substituted hydrocarbon moiety.

33. A composition prepared by the process of claim 13 or claim 14.

34. A composition prepared by the process of claim 27 or claim 28.